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A CONTRIBUTION TO THRIPS-PLANT ASSOCIATIONS RECORDS (INSECTA: THYSANOPTERA) IN COSTA RICA AND CENTRAL AMERICA

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ABSTRACT

Thrips are small, cosmopolitan insects directly or indirectly associated with plants. Records of these associations in the neotropics add greatly to better understanding of Thysanoptera, not the least because some thrips species are economically important in agriculture and amenity plantings. In this paper we report new plant associations of *Franklinothrips vespiformis* (Crawford), *Gastrothrips* sp. Hood, *Haplothrips gowdeyi* Franklin, *Leptothrips astutus* Johansen, *Leptothrips obesus* Johansen, *Liothrips* spp. Uzel, *Torvothrips martinezi* Johansen, *Arorathrips mexicanus* Crawford, *Caliothrips fasciapennis* (Hinds), *Caliothrips nanus* (Hood), *Caliothrips punctipennis* (Hood), *Echinothrips caribbeanus* Hood, *Echinothrips selaginellae* Mound, *Frankliniella cephalica* Crawford, *Frankliniella standleyana* Hood, *Hoodothripiella ignacio* Retana-Salazar, *Microcephalothrips abdominalis* (Crawford) and *Retanathrips silvestris* (Hood). Some records of the presence of thrips species are new for Costa Rica and Central America.

Key Words: amenity plantings, arvenses, banana, ecology, weeds, accomplice species, host

RESUMEN

Los thrips son pequeños insectos cosmopolitas asociados a las plantas directa o indirectamente. El conocimiento de asociaciones con plantas es información valiosa para un mejor conocimiento de este grupo, poco es conocido en las regiones neotropicales donde algunas especies son plagas agrícolas importantes. En este escrito se presentan nuevos registros de asociaciones con plantas para *Franklinothrips vespiformis* (Crawford), *Gastrothrips* sp. Hood, *Haplothrips gowdeyi* Franklin, *Leptothrips astutus* Johansen, *Leptothrips obesus* Johansen, *Liothrips* spp. Uzel, *Torvothrips martinezi* Johansen, *Arorathrips mexicanus* Crawford, *Caliothrips fasciapennis* (Hinds), *Caliothrips nanus* (Hood), *Caliothrips punctipennis* (Hood), *Echinothrips caribbeanus* Hood, *Echinothrips selaginellae* Mound, *Frankliniella cephalica* Crawford, *Frankliniella standleyana* Hood, *Hoodothripiella ignacio* Retana-Salazar, *Microcephalothrips abdominalis* (Crawford) y *Retanathrips silvestris* (Hood). Algunos reportes son nuevos para Costa Rica y para Centroamérica.

Translation provided by the authors.

With more than 2000 thrips species currently described in the Neotropics, this region has great diversity within the Thysanoptera (Mound 2002). Species from 1.0 mm or less to 10.0 mm long can be found just in Central America (Mound et al. 1993) where they can be collected from a wide array of habitats; forests, grasslands, desserts, crops and gardens (Soto-Rodríguez et al. 2009). Feeding habits vary among different taxa (Mound et al. 1993; Soto-Rodríguez et al. 2009) and, commonly, phytophagous species are considered of economic importance in various crops (Childers & Nakahara 2006; González et al. 2010a), especially in the tropics (Johansen & Mojica 2007). Phytophagous species cause economic damage by feeding directly on vulnerable plant species, by vectoring virus causing major crop losses (Jones 2005) or requiring the erection of quarantine barriers to their spread (Vierbergen et al. 2006; González et al. 2010b). On the other hand, other thrips species serve beneficially as pollinators and decomposers (Pinent et al. 2006), and some species have been suggested as biological control agents against various arthropod pests (Zegula et al. 2003) or weeds (Cock et al. 2000; Mound & Zapater 2003; Soto-Rodríguez et al. 2009). Weeds often are very important in agriculture because they compete with the crop, or they serve as hosts or accomplices of pests or pathogens including some thrips species (González et al. 2010b). Hernández-Ayar et al. (2009), for example, found that the number of thrips taxa present at a given site varied according to the type of plants that grow associated with the crop, in this case, Persian lime, *Citrus latifolia* (Tan.).

According to Mound (2002), the majority of thrips studies in the neotropics have been limited to insecticide trials or taxonomic studies. Therefore it is especially important to conduct plant-association surveys in order to understand the role of thrips species in the ecosystems, to ascertain which plant species aid and abet various species of thrips pests (González et al. 2010b), and to assess the impact of different thrips species on populations of other organisms within crops, amenity plantings or noncultivated areas. In this paper we present the findings of Neotropical and cosmopolitan thrips species collected from weeds from banana farms and neighboring areas such as paddocks and roadsides.

Materials and Methods

Implementation of Project CONICIT FV 24-07, UCR 813-A8-506, involved the monthly collection of foliar samples (leaves, stems and flowers in few cases) of several weed species in Limón, Costa Rica throughout 2008 and 2009. Weed samples were collected in plastic bags and sealed with adhesive tape to prevent the escape of captured specimens. Plants samples were identified *in situ* and their identities were verified by Steven Brenes of the Weed Laboratory of the University of Costa Rica. Most of the samples were collected within banana farms, other samples were obtained from neighboring areas and pasture fields.

To extract the thrips specimens, each weed sample was placed in a container filled with boiling water. After approximately 3 minutes, the water was poured through a 212 mesh sieve. The plant sample was washed twice in the container and the water was poured through the sieve. Specimens on the sieve were transferred to a petri plate, after which the thrips were stored in 70% ethanol in labeled eppendorf tubes for further identification. The thrips specimens were mounted on microscope slides and were identified by Axel Retana-Salazar of the Centro de Investigación en Estructuras Microscópicas (CIEMIC), University of Costa Rica, according to the keys provided by Johansen (1980, 1987); Mound et al. (1993); Mound & Marullo (1996); Soto-Rodríguez & Retana-Salazar (2003); Retana-Salazar (2007) and the Official Collection of Thysanoptera of the University of Costa Rica, CIEMIC.

Results and Discussion

Locations and dates of sampling for thrips reported in this project are elaborated in Table 1. In total 829 plant samples were collected and examined. Three thrips families, 13 genera and 19 species were identified in this research, and these19 species were involved in 45 different thrips-plant associations (Table 2).

Most of the thrips specimens were found on samples collected from outside the banana farms, and this distribution is consistent with other arthropod taxa observed during this research (Fig. 1). Weed samples belonged to 70 different

Table 1. Collection of thrips on weeds in Limón Province, Costa Rica in 2008-2009: locations, site descriptions and dates of collection.

Location code	Date of sampling	Location name	Detail
1	3-IV-2008	La Teresa Banana Farm	Cariari, Limón.
2	3-IV-2008	Junior Jiménez Paddock	Guácimo, Limón.
3	12-IV-2008	Est. Exp. Diamantes, INTA (Paddock) 1	Guápiles, Limón.
4	7-V-2008	Agrícola 2 Banana Farm	Cariari, Limón.
5	8-V-2008	Roadside to Guácimo	Guácimo, Limón.
6	8-V-2008	San Diego Pineapple Farm (nearby)	Guácimo, Limón.
7	27-V-2008	Bonanza Campo Cinco Banana Farm	Cariari, Limón.
8	28-V-2008	Est. Exp. Diamantes, INTA (Paddock) 2	Guápiles, Limón.
9	6-VIII-2008	Rio Palmas Hotel surrounding forest	Guácimo, Limón
10	4-IX-2008	San Pablo Banana Farm	Matina, Limón.
11	4-IX-2008	28 Millas, CORBANA facilities	Matina, Limón.
12	9-X-2008	Calinda Banana Farm	Guácimo, Limón.
13	10-X-2008	6 years Organic Banana Farm, EARTH	EARTH University, Guácimo, Limón
14	11-II-2009	Támesis Banana Farm	Cariari, Limón.
15	11-II-2009	Valquirias Banana Farm	Cariari, Limón.
16	12-III-2009	Bananos Dora Banana Farm	Siquirres, Limón
17	13-III-2009	Ecoturismo Banana Farm	Siquirres, Limón
18	8-VII-2009	La Estrella Banana Farm	Siquirres, Limón
19	16-IX-2009	Verde Azul Banana Farm	Siquirres, Limón

TABLE 2. ASSOCIATIONS OF THYSANOPTERAN FAMILIES AND SPECIES WITH FAMILIES AND SPECIES OF PLANTS AT THE LOCATIONS SAMPLED IN LIMÓN PROVINCE, COSTA RICA IN 2008-2009.

Thrips species/weed species	Host Botanical Family	Location Code[1]
AEOLOTHRIPIDAE		
Franklinothrips vespiformis		
Synedrella nodiflora L.	Asteraceae	1
PHLAEOTHRIPIDAE		
Idolothripinae		
Gastrothrips sp.		
Solanum nigrum L.	Solanaceae	17
Phlaeothripinae		
Haplothrips gowdeyi		
Digitaria setigera Roth ex Roem. et Schult.	Poaceae	18
Eleusine indica L.	Poaceae	10, 19
Emilia sonchifolia L.	Asteraceae	17
Spermacoce assurgens Ruiz & Pavón	Rubiaceae	8, 9
Leptothrips astutus		
Stachytarpheta jamaicensis L.	Verbenaceae	4
Synedrella nodiflora L.	Asteraceae	1, 5, 6, 9
Leptothrips obesus		
Lantana trifolia L.	Verbenaceae	2, 8
Liothrips sp.1		
Synedrella nodiflora L.	Asteraceae	5, 7, 8, 19
Liothrips sp.2		
Gouania polygama Jacq.	Rhamnaceae	3, 8, 13
Torvothrips martinezi		
Sida ulmifolia Mill.	Malvaceae	8
THRIPIDAE		
Arorathrips mexicanus		
Drymaria cordata L.	Caryophyllaceae	2, 6, 10, 17
Eleusine indica L.	Poaceae	2, 7, 10, 16
Caliothrips faciapennis		
Scleria melaleuca Rchb.f. ex. Schtdl.Cham.	Cyperaceae	2, 3, 6, 8, 15, 17
C*aliothrips nanus*		
Gouania polygama Jacq.	Rhamnaceae	3, 11,13
Caliothrips punctipennis		
Eleusine indica L.	Poaceae	4, 10, 12, 16, 18
Echinothrips caribbeanus		
Alternanthera sessilis L.	Amaranthaceae	10
Cyathula prostrata L.	Amaranthaceae	15, 17
Drymaria cordata L.	Caryophyllaceae	2, 8, 15
Eleusine indica L.	Poaceae	4, 16
Emilia sonchifolia L.	Asteraceae	17
Laportea aestuans L.	Urticaceae	1, 3, 12, 13, 14, 15, 16
Ludwigia decurrens Walt.	Onagraceae	16
Melothria pendula L.	Cucurbitaceae	1, 17
Mikania micrantha Kunth ex H.B.K	Asteraceae	15
Oxalis barrelieri L.	Oxalidaceae	7
Phenax sonneratii Poir.	Urticaceae	17
Philodendron hederaceum (Jacq.) Schott	Araceae	12, 17
Rivina humilis L.	Phytolacaceae	16, 17

[1]Each Location Code is defined in Table 1.

TABLE 2. (CONTINUED) ASSOCIATIONS OF THYSANOPTERAN FAMILIES AND SPECIES WITH FAMILIES AND SPECIES OF PLANTS AT THE LOCATIONS SAMPLED IN LIMÓN PROVINCE, COSTA RICA IN 2008-2009.

Thrips species/weed species	Host Botanical Family	Location Code[1]
Solanum nigrum L.	Solanaceae	17
Spermacoce assurgens Ruiz & Pavón	Rubiaceae	15
Synedrella nodiflora L.	Asteraceae	10, 19
Echinothrips selaginellae		
Alternanthera sessilis L.	Amaranthaceae	10, 14, 15
Laportea aestuans L.	Urticaceae	12, 19
Scleria melaleuca Rchb.f. ex. Schtdl.Cham.	Cyperaceae	12, 17
Frankliniella cephalica		
Drymaria cordata L.	Caryophyllaceae	2, 11
Frankliniella standleyana		
Conostegia subcrustulata Beurl.	Melastomataceae	6
Mikania micrantha Kunth ex H.B.K	Asteraceae	7, 14, 15
Hoodothripiella ignacio		
Spermacoce latifolia Aubl.	Rubiaceae	2, 7, 8, 9
Microcephalothrips abdominalis		
Wedelia trilobata L.	Asteraceae	10, 11
Retanathrips silvestris		
Alternanthera sessilis L.	Amaranthaceae	16
Spermacoce latifolia Aubl.	Rubiaceae	7, 9
Spermacoce assurgens Ruiz & Pavón	Rubiaceae	8, 16
Synedrella nodiflora L.	Asteraceae	5, 6, 7, 8, 9

[1]Each Location Code is defined in Table 1.

species and the thrips specimens were found on 17 of 28 botanical families represented at the sampling sites. The highest number of thrips species (Fig. 2) was found on members of the Asteraceae. *Echinothrips caribbeanus* Hood was found on 16 plant species (Fig. 3), the most for any thrips species herein. Twelve thrips species were narrowly specific in their plant preferences; each being found on a single plant species (Fig. 3). Information of other locations and weed species sampled are detailed in Sánchez-Monge (2010).

AEOLOTHRIPIDAE

Franklinothrips Back 1912

Franklinothrips vespiformis (Crawford 1909)

F. vespiformis is a known predator of mites, white flies and other insects in Central and South America (Arakaki *et al.* 2001) as well as the Southwestern USA (Johansen 1983). *F. vespiformis* has been recorded previously from grasses, weeds and crops species in several Latin-American countries (Johansen 1976, 1983; Mound & Reynaud 2005). In Costa Rica *F. vespiformis* was reported on *Ricinus* sp. leaves (Mound & Marullo 1996) and associated with crops (Soto-Rodríguez *et al.* 2009). Our finding of *F. vespiformis* on *Synedrella nodiflora* (Asteraceae) (Table 2) is new information on its biology. We also found Homoptera immatures, predatory and phytophagous mites and some nematodes in this weed sample, some of them could be suitable prey for *F. vespiformis*, since its predatory behavior on small insects, eggs and other larvae has been documented (Johansen 1976; Mound & Reynaud 2005). The small number of *F. vespiformis* isolated from the weed sample is consistent with solitary predator behavior described for predator thrips species (Johansen & Mojica-Guzmán 1996).

PHLAEOTHRIPIDAE

Idolothripinae

Gastrothrips Hood 1912

Gastrothrips sp.

The specimen collected on black nightshade, *Solanum nigrum* L., (Table 2) has the major characters of the genus according to Mound & Marullo (1996), however the tube is not constricted at the apex, as is usually the case in New World species (Mound & Marullo 1996). Since *Gastrothrips* is a fungal spore feeding genus, there is not a direct

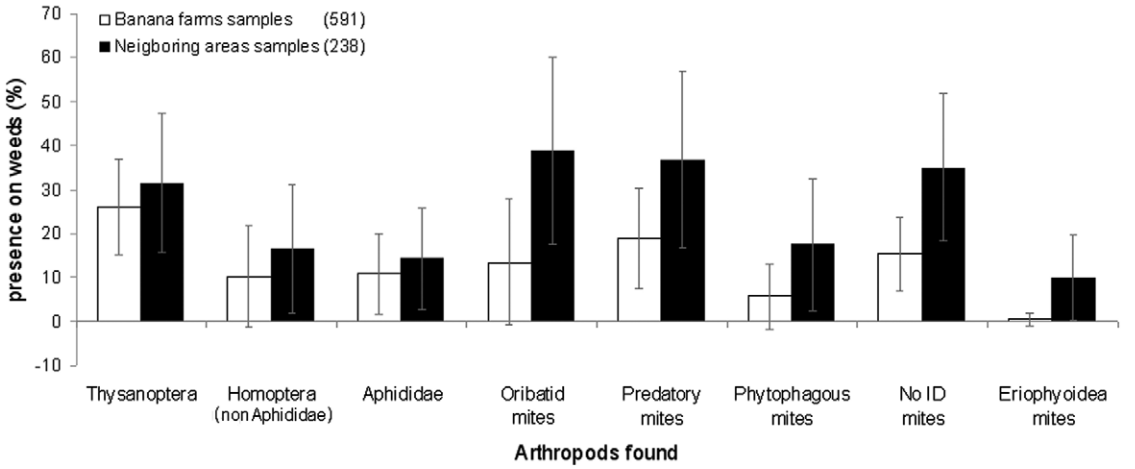

Fig. 1. Average percentages of various insect and mite taxa found in weed samples from 19 banana farms and 12 neighboring areas in Limón Province, Costa Rica in 2008-2009. Each vertical error bar represents the standard error of the mean percentage of the indicated taxon present either on banana farms or surrounding areas. The numbers of samples taken at each of these 2 types of sites are shown in parentheses.

host relationship of *Gastrothrips* sp. with *S. nigrum*; however, the plant species on which this thrips subfamily is found are always recorded (Sakimura & Bianchi 1977), and, indeed, some species in the Idolothripinae can also be found on dead leaves on hanging broken branches (Hoddle et al. 2004). It is interesting to point out that this specimen was found on just 1 of the 70 plant species sampled, and samples of the weeds surrounding in this location did not have any other specimens of *Gastrothrips*. A few Thysanoptera larvae were isolated from a *S. nigrum* sample at location 9 (Table 1), but we could not define their identity because diagnostic information on larval taxonomy is inadequate.

Phlaeothripinae

Haplothrips Amyot & Serville 1843

Haplothrips gowdeyi Franklin 1908

H. gowdeyi is a very common species in the Caribbean area (Mound & Marullo 1996), and it has been reported on pineapple, *Ananas comosus* (L.) Merr., species of *Aster* and *Bidens* (Asteraceae), *Salvia* (Lamiaceae), *Althaea* (Malvaceae)

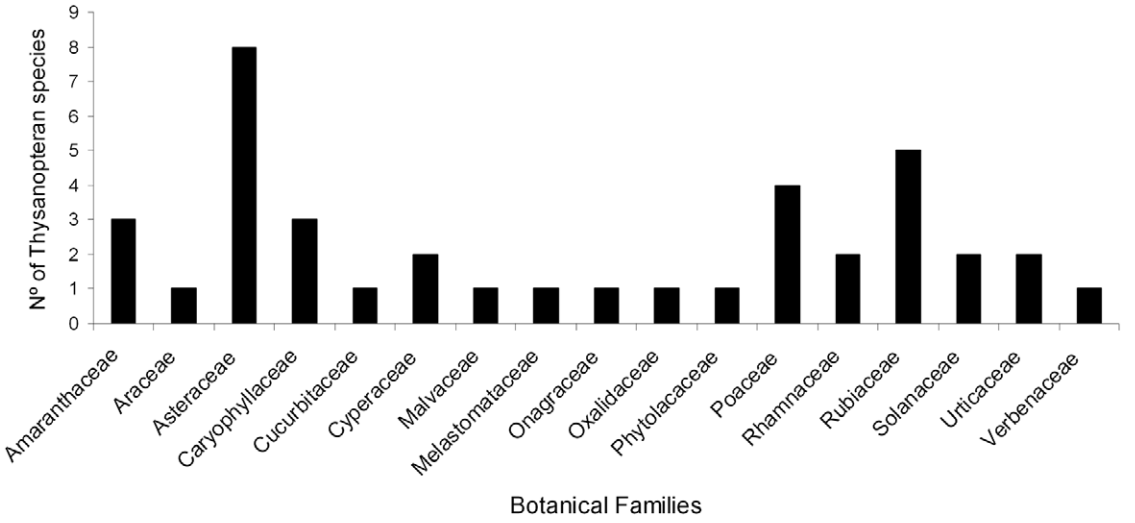

Fig. 2. Number or thrips species (Insecta: Thysanoptera) found on plant species belonging to each of the 17 botanical families sampled on 19 banana farms and 12 neighboring areas in Limón Province, Costa Rica in 2008-2009.

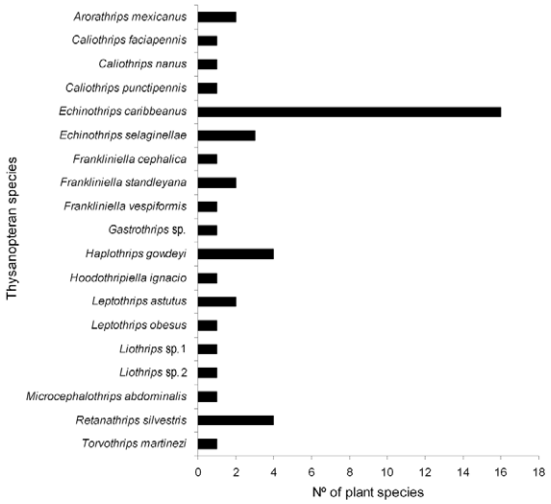

Fig. 3. Number of plant species on which each of the 19 Thysanopteran species was found while collecting samples from 70 species of plants belonging to 17 botanical families on banana farms and surrounding areas in Limón Province, Costa Rica in 2008-2009. The 19 thrips species represent 13 genera belonging to the Aeolothripidae, Phlaeothripidae and Thripidae.

and others in Costa Rica (Soto-Rodríguez *et al.* 2009), sugarcane leaves in South Africa (Way, 2008) and common pigweed, *Amaranthus hybridus* L., in Florida (Childers & Nakahara 2006). Herein (Table 2) we report new associations with Asteraceae (*Emilia sonchifolia* (L.) DC, lilac tasselflower), Rubiaceae (*Spermacoce assurgens* Ruiz & Pav., woodland false buttonweed) and Poaceae (*Digitaria setigera* Roth ex Roem. & Schult., East Indian crabgrass; and *Eleusine indica* (L.) Gaertn., Indian goosegrass). On these same samples we found some Thysanoptera larvae but we could not determine their identity.

Leptothrips Hood 1909

Leptothrips astutus Johansen 1978

L. astutus, a predatory thrips species, was found on several plant species in several botanical families (Johansen 1987) but our finding on *Stachytarpheta jamaicensis* (L.) Vahl, worryvine (Verbenaceae), is a first for this species (Table 2). This weed was sampled once and diverse organisms were isolated from it, i.e., Homoptera, Aphididae, nematodes and predatory mites. On *Synedrella nodiflora* (L.) Gaertn., nodeweed (Asteraceae), it was common to find Homoptera and Thysanoptera instars, aphids, oribatid and predatory mites among others that could be used as prey by this species (Johansen & Mojica-Guzmán 1996). This weed species was sampled 22 times. All *S. nodiflora* samples from areas neighboring banana farms and 62.5% of samples from within banana farms contained *L. astutus* adults, and some also contained unidentified thrips larvae.

Leptothrips obesus Johansen 1987

L. obesus was reported on *Verbesina greenmanii* Urb. (Asteraceae), and it was listed as the unique species of this genus for Mexico (Johansen 1987). This is the first report of this species for Central America, as well as the first report on *Lantana trifolia* L. and within the Verbenaceae family (Table 2). This weed was sampled twice in 2 different locations (paddocks), both of them had *L. obesus* specimens and predatory, phytophagous and unidentified mites that could become suitable prey for *L. obesus*. Homopterans were also represented in both samples and eriophyoid mites in 1 sample (Sánchez-Monge 2010).

Liothrips Uzel 1895

Liothrips spp.

Even though *Liothrips* is the largest genus within the Thysanoptera (Mound & Morris 2007), and even though some *Liothrips* species have been proposed as biocontrol agents of weeds (Cock *et al.* 2000; Mound & Pereyra 2008; Soto-Rodríguez *et al.* 2009), little is known about *Liothrips* hosts and accomplices in Central America, since most neotropical species are reported from Brazil (Mound & Pereyra 2008). Herein we report *Synedrella nodiflora* (Asteraceae) and *Gouania polygama* (Jacq.) Urb., liane savon (Rhamnaceae), as possible new hosts for *Liothrips* species (Table 2); several adults were found in most samples of these weeds and they were found most frequently outside of banana farms (Table 2). We also found some Thysanoptera larvae on these plant species, but we could not identify them due to the lack of larval keys to genera in current literature.

Torvothrips Johansen 1977

Torvothrips martinezi Johansen 1980

According to the key provided by Johansen (1980), the specimen we collected corresponds to *T. martinezi*; nevertheless, some characters do not fit with the species description, which lacks data on associated plant species. We found *T. martinezi* on *Sida ulmifolia* Mill. *Torvothrips* is Mexican in origin (Johansen 1982), and other species of this genus, i.e., *T. tremendous* (Johansen) and *T. kosztarabi* (Johansen), are associated with galls in *Quercus* spp. (Johansen 1982, Kosztarab 1982). The genus *Torvothrips* includes only parasitoid species within galls of the coccids, *Olliffiella* spp. (Kermisidae) (Johansen & Mojica-Guzmán 1996), but it is interesting that this taxon was not

found in any other sample during this research; not even in other samples collected at the same location. This is also the first record of *T. martinezi* for Costa Rica and Central America.

THRIPIDAE

Arorathrips Bhatti 1990

Arorathrips mexicanus Crawford 1909

A. mexicanus is widely distributed in neotropics where it is commonly associated with grasslands (Mound & Marullo 1996; Schuber et al. 2008), and it has been also reported from sugarcane leaves in South Africa (Way, 2008). We found *A. mexicanus* on 63% of *Drymaria cordata* L. (Caryophyllaceae) samples, and, other than on *Eleusine indica*, this thrips species has not been found on any monocotyledonous weed during this research (Table 2).

Caliothrips Daniel 1904

Caliothrips fasciapennis (Hinds 1902)

According to Mound & Marullo (1996), *C. faciapennis* has been collected from grasslands in North America, i.e., from Massachusetts and Illinois to California, Florida and Texas and as far as Mexico. Our report on *Scleria melaleuca* Rchb.f. ex. Schtdl. Cham. (Cyperaceae), a common weed on Neotropical grasslands (Gómez-Gómez *et al.* 2008), is a first of this thrips on a plant species in the Cyperaceae, and the first report of this thrips species for Central America. We found *C. fasciapennis* on all the samples from paddocks, a few specimens were isolated from 2 banana farm samples and 1 from another neighboring area (Table 2). Some thrips larvae were found on this weed species but their identities were not determined.

Caliothrips nanus (Hood 1927)

C. nanus is easy to recognize by the 2 dark stout grooved setae near the forked vein in the forewing, this species is known from Trinidad and West Indies (Wilson 1975), and has been reported from Panama by Mound & Marullo (1996). It was collected from *Parkinsonia aculeate* L., Jerusalem thorn (Fabaceae), in Trinidad, *Mucuna* (Fabaceae) leaves in Panama and from *Gliricidia sepium* (Jacq.) Kunth ex Walp., quickstick (Fabaceae), and *Ipomoea* (Convolvulaceae) leaves in Costa Rica. Although the specimens were isolated from few samples, all samples correspond to the same weed species: *Gouania polygama* (Rhamnaceae).

Caliothrips punctipennis (Hood 1912)

Apparently *C. punctipennis* is a grass feeder (Sakimura 1991), and it was previously reported in Mexico and Texas (Mound & Marullo 1996). Recent literature reports its presence in avocado trees in Mexico (Johansen & Mojica 2007). This is the first report (Table 2) on the grass *Eleusine indica* and the first report for Costa Rica and Central America.

Echinothrips Moulton 1911

Echinothrips caribbeanus Hood 1955

E. caribbeanus was collected in Panama and has been reported on at least 3 botanical families, i.e., Capparidaceae, Menispermaceae and Cucurbitaceae (Mound & Marullo 1996). The hosts reported in this paper (Table 2) are new records at the species and family level, except for Cucurbitaceae. Its occurrence on *Laportea aestuans* L. (Urticaceae) is remarkable since *E. caribbeanus* was present at 7 different locations, most of them banana farms (Table 1). *E. caribbeanus* was also particularly common at location 17, Ecoturismo Banana Farm (Table 2).

Echinothrips selaginellae Mound 1994

E. selaginella was collected on *Selaginella eurynota* A. Braun, spikemoss (Selaginellaceae) (Mound et al. 1994; Mound & Marullo 1996), and it is known only from Costa Rica. Our report on *Alternanthera sessilis* (Amaranthaceae), *Laportea aestuans* (Urticaceae) and *Scleria melaleuca* (Cyperaceae) are new association records for this species (Table 2), implying that this thrips might not has a strict monophagous habit, as it was asserted by Mound (2002). Unfortunately, we did not find any thrips larvae on these weeds species; but it is important to point out that *E. selaginellae* was present only on these weeds throughout 2 years of sampling, involving 70 weed species and 829 samples.

Frankliniella Karny 1909

Frankliniella cephalica Crawford 1910

F. cephalica is widely distributed in the Caribbean and it has been collected in Costa Rica from different locations and altitudes (Mound & Marullo 1996). This species has been reported on several hosts species and botanical families (Masís & Madrigal 1994) including mangroves (Frantz & Mellinger 1990). Herein we present the first report of *F. cephalica* on *Drymaria cordata* L. (Caryophyllaceae).

Frankliniella standleyana Hood 1935

F. standleyana was reported from *Conostegia subcrustulata* (Beurl.) Triana (Melastomataceae) flowers (Mound & Marullo 1996), but our finding is the first record for this species on *Mikania mi-*

crantha Kunth ex H.B.K and its botanical family (Asteraceae). Some unidentified Thysanoptera larvae were associated to *M. micrantha* at locations 7, 17 and 19 (Table 1), however, this Asteraceae was the only weed (other than *C. subcrustulata*) on which we found *F. standleyana*.

Hoodothripiella Retana-Salazar 2007

Hoodothripiella ignacio Retana-Salazar 2007

H. ignacio was found previously in several areas in Costa Rica; but the relevant plant species for these samples were not determined because they were collected with Malaise Traps (Retana-Salazar 2007). The presence of *H. ignacio* on *Spermacoce latifolia* Aubl. (Rubiaceae) is the first report on this weed species and its botanical family; this is important biological data on this thrips species. Interestingly, *H. ignacio* was found more frequently at locations outside the banana farms (Table 2) and it was not found on related weed species (*Spermacoce assurgens* or *S. capitata* Ruiz & Pav.).

Microcephalothrips Bagnall 1926

Microcephalothrips abdominalis (Crawford 1910)

M. abdominalis is a pest in ornamentals (Vierbergen et al. 2006), and an important vector of the Tobacco Streak Virus in Tobacco (Greber et al. 1991). Previously *M. abdominalis* was reported on *Ageratum conizoides* Lam., goat weed (Compositae-Eupatorieae) (Mound & Marullo 1996), Chrysanthemum and *Bidens pilosa* L. (Asteraceae) (Childers & Nakahara 2006). *M. Abdominalis*, is commonly associated with various Asteraceae genera (Childers & Nakahara 2006; Pirec 2007), but this is the first report of *M. abdominalis* on *Wedelia trilobata* L. (Asteraceae). *M. abdominalis* was sampled twice on *Wedelia trilobata* L.; whereas it was not found on any of the other 69 weed species sampled.

Retanathrips Mound & Nickle 2009

Retanathrips silvestris (Hood 1935)

Several specimens of *R. silvestris* were collected from 4 different plant species belonging to 3 botanical families (Table 2). All of them are new records for this taxon since the description of the *Retanathrips* species was based on few specimens and the associated plant species were not reported in this original work. Mound & Marullo (1996) considered that this species probably lives on the leaves of forest trees, but our reports suggests that *R. silvestris* is common on some weed species, especially *Synedrella nodiflora* (Asteraceae) (Table 2), on which specimens were found in 4 different locations and 1 banana farm (Table 1). The infrequent collection of this species may be result of incorrect searching and sampling procedures.

Few studies have focused on the diversity of Thysanoptera on plant species, whether beneficial or harmful, or on weeds associated with crops. As a matter of fact, the interaction of weeds and arthropods has been largely ignored in surveys of agricultural landscapes (Bàrberi et al. 2010). Most literature on Thysanoptera treats only taxonomy, pest species, control of pest populations and other practical topics (Mound 2005). Commonly, data on biology or ecology are not detailed in descriptions of species (Monteiro 2001). Consequently, the lack of such information, at best, results in sketchy and partial knowledge of the habits and behavior of Thysanopteran species. Childers & Nakahara (2006) found thrips species to be associated with weed cover, which varied seasonally. Moreover, Hernández-Ayar et al. (2009) found that the diversity of Thysanoptera was different according to the sample location and the vegetation at each site; that the number of captured thrips species was higher in locations with weed cover than where a crop was associated with a limited number of weeds; and that the number of thrips species was lower at locations with the crop and only 1 other plant species used as a cover. Such findings are predictable because diversity of substrates serves to maintain populations of different arthropod species; and through plant species diversity the number of possible ecological associations is increased. This principle has been applied in several agricultural landscapes and crops for increasing the diversity of insects and the presence of natural enemies for pests (Schellhorn & Sork, 1997).

According to Mound (2005), a thrips' host is commonly defined as a plant species on which a thrips species can successfully maintain a population; thus all life stages of a species of thrips must be able thrive on a plant species in order for it to be designated a host of the thrips species. This definition excludes plant species, which fail to meet this stringent definition, but which, nevertheless, still aid and abet the thrips species. Such accomplice plant species include those which may occasionally allow small thrips populations to establish and multiply fleetingly, and those on which adult thrips feed and acquire or transmit viruses, yet which fail to support the establishment of reproducing and multigenerational populations of certain thrips species. Clearly it is insufficient to rigidly classify plant species as either hosts or non-hosts of thrips species, because some plant species serve importantly as accomplice species.

Surveys like that of Hernández-Ayar et al. (2009) and the results obtained in this paper (Fig. 1) point out the effect that a crop or farm has on various arthropod populations. Moreover, these 2

studies have elucidated the diversity of direct and indirect associations between specific thrips species and specific plant species (Figs. 2 and 3). Further surveys on abundance and diversity of Thysanoptera on weeds are needed to clarify the relationships of these insects and their environments in the tropics, their impacts on plant and arthropod populations, and their population dynamics in cultivated and non cultivated areas.

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